This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (currently amended) A method for determining an overlay error between at least two layers in a multiple layer sample, the method comprising:

(a) using an optical system to measure a plurality of measured optical signals from a plurality of periodic targets on the sample, wherein the periodic targets each have a first structure in a first layer and a second structure in a second layer, wherein there are predefined offsets between the first and second structures; and

(b) using a scatterometry overlay technique to analyze the measured optical signals of the periodic targets and the predefined offsets of the first and second structures of the periodic targets to thereby determine and store an overlay error between the first and second structures of the periodic targets, wherein the scatterometry overlay technique is a phase based technique that includes representing each of the measured optical signals as a set of periodic functions having a plurality of known parameters and a plurality of unknown parameters that include an unknown overlay error parameter and analyzing the set of periodic functions to solve for the unknown overlay error parameter to thereby determine the overlay error, wherein the number of periodic targets equals the number of unknown parameters.

2. (previously presented) A method as recited in claim 1, wherein the optical system is configured to have an illumination and/or collection numerical aperture (NA) and/or spectral band selected so that only a specific diffraction order is collected and measured for the plurality of measured optical signals.

3. (previously presented) A method as recited in claim 2, wherein the optical system is configured to have an illumination and/or collection NA and/or spectral band selected so that only a 0^{th} diffraction order is collected and measured for the plurality of measured optical signals and wherein the illumination NA of the optical system equals the collection NA, an incident beam of the optical system is normal to a surface of the sample, and the optical system is configured to meet the following condition:

$$n\lambda=d(NA_i+NA_c)$$

wherein n equals 1, λ is the wavelength, d is a pitch of the target's structures, NA_i is the illumination numerical aperture, and NA_c is the collection numerical aperture.

4. (currently amended) A method as recited in claim 2, wherein the illumination NA of the optical system equals the collection NA, an incident beam of the optical system is normal to a surface of the sample, and the optical system is configured to meet the following condition:

$$n\lambda\geq 2dNA(1+\epsilon)$$

wherein n equals 1, λ is the wavelength, d is a pitch of the target's structures, NA is the numerical aperture of the optical system, and ~~is~~ ϵ <u>is</u> an approximation factor for structures of the periodic targets which are not infinitely periodic.

5. (original) A method as recited in claim 4, wherein ϵ is about less than 0.5.

6. (previously presented) A method as recited in claim 2, wherein the spectral band of the optical system is selected by adjusting a wavelength selection device or the wavelength modulation device.

7. (currently amended) A method as recited in claim 6, wherein the wavelength selection device is from a group consisting of a set of band pass interference filters, a set of continuously varying bandpass ~~interferencede~~ interference filters, a set of grating based spectrometers, a set of Fourier transform interferometers, and a set of acousto-optic tunable filters and the wavelength modulation device is controlled by changing one or more optical path lengths therein.

8. (previously presented) A method as recited in claim 6, wherein the wavelength selection device or the wavelength modulation device is positioned within the optical system's illumination path.

9. (previously presented) A method as recited in claim 6, wherein the wavelength selection device or the wavelength modulation device is positioned within the optical system's collection path.

10. (previously presented) A method as recited in claim 6, wherein the optical system further includes a polarizer in the illumination path and an analyzer in the collection path.

11. (original) A method as recited in claim 2, wherein the analysis of the measured optical signals includes deriving spectral information from the measured optical signals using a transform, such as a Fourier or a Hadamard transform.

12. (original) A method as recited in claim 2, wherein the measured optical signals are in the form of one or more image(s).

13. (original) A method as recited in claim 12, wherein the one or more images include center portions of each target and the image center portion of each target is analyzed.

14. (original) A method as recited in claim 2, wherein the overlay error is determined without comparing any of the measured optical signals to a known or reference signal from a sample target having a known overlay error.

15. (original) A method as recited in claim 2, wherein each first structure has a first center of symmetry and each second structure has a second center of symmetry and wherein the first center of symmetry and the second center of symmetry for each target are offset with respect to each other by a selected one of the predefined offsets.

16. (original) A method as recited in claim 2, wherein the overlay error is determined without comparing the measured optical signals to calibration data.

17-18. (cancelled)

19. (previously presented) A method as recited in claim 1, wherein the optical system has a broadband source for generating an optical incident beam having multiple wavelengths, a detector for detecting a measured signal from the sample in response to the incident beam and a filter for selectively passing particular one or more wavelengths of the output signal to the detector, wherein using the optical system includes directing at least one radiation beam towards each target to measure a plurality of measured signals from the periodic targets while adjusting the filter so as to pass a particular one or more wavelengths of the measured signals through the filter towards the detector in the form of a plurality filtered signals.

20. (currently amended) A method ~~as recited in claim 19,~~ <u>for determining an overlay error between at least two layers in a multiple layer sample, the method comprising:</u>

<u>(a) using an optical system to measure a plurality of measured optical signals from a plurality of periodic targets on the sample, wherein the targets each have a first structure in a first</u>

layer and a second structure in a second layer, wherein there are predefined offsets between the first and second structures; and

(b) using a scatterometry overlay technique to analyze the measured optical signals of the periodic targets and the predefined offsets of the first and second structures of the periodic targets to thereby determine and store an overlay error between the first and second structures of the periodic targets, wherein the scatterometry overlay technique is a phase based technique that includes representing each of the measured optical signals as a set of periodic functions having a plurality of known parameters and an unknown overlay error parameter and analyzing the set of periodic functions to solve for the unknown overlay error parameter to thereby determine the overlay errors,

wherein the optical system has a broadband source for generating an optical incident beam having multiple wavelengths, a detector for detecting a measured signal from the sample in response to the incident beam and a filter for selectively passing particular one or more wavelengths of the output signal to the detector, wherein using the optical system includes directing at least one radiation beam towards each target to measure a plurality of measured signals from the periodic targets while adjusting the filter so as to pass a particular one or more wavelengths of the measured signals through the filter towards the detector in the form of a plurality filtered signals, and

wherein the analysis of the filtered signals and the predefined offsets includes obtaining an intensity from some or all of the pixels of an image of each target and combining the intensities of each target together to give an intensity value for each target at a particular setting of the filter.

21. (cancelled)

22. (original) A method as recited in claim 20, wherein the analysis of the filtered signals and the predefined offsets further includes determining a periodic function of the overlay error based on the intensity values for each target and determining the overlay error based on such periodic function.

23. (original) A method as recited in claim 20, wherein the filter is adjusted so as to give a maximum difference between the target's intensity values.

24. (currently amended) A method ~~as recited in claim 19, further comprising~~ for determining an overlay error between at least two layers in a multiple layer sample, the method comprising:

(a) using an optical system to measure a plurality of measured optical signals from a plurality of periodic targets on the sample, wherein the targets each have a first structure in a first layer and a second structure in a second layer, wherein there are predefined offsets between the first and second structures; and

(b) using a scatterometry overlay technique to analyze the measured optical signals of the periodic targets and the predefined offsets of the first and second structures of the periodic targets to thereby determine and store an overlay error between the first and second structures of the periodic targets, wherein the scatterometry overlay technique is a phase based technique that includes representing each of the measured optical signals as a set of periodic functions having a plurality of known parameters and an unknown overlay error parameter and analyzing the set of periodic functions to solve for the unknown overlay error parameter to thereby determine the overlay errors,

wherein the optical system has a broadband source for generating an optical incident beam having multiple wavelengths, a detector for detecting a measured signal from the sample in

<u>response to the incident beam and a filter for selectively passing particular one or more wavelengths of the output signal to the detector, wherein using the optical system includes directing at least one radiation beam towards each target to measure a plurality of measured signals from the periodic targets while adjusting the filter so as to pass a particular one or more wavelengths of the measured signals through the filter towards the detector in the form of a plurality filtered signals;</u>

repeating operation (a) over multiple wavelengths, wherein the measured optical signals having the largest contrast are used to determine overlay error.

25. (previously presented) A method as recited in claim 19, further comprising repeating operation (a) over multiple wavelengths, wherein a weighted average of the measured optical signals is used to determine overlay error.

26. (original) A method as recited in claim 20, further comprising analyzing the image of the periodic targets to detect any processing problems other than those caused by overlay error.

27. (previously presented) A method as recited in claim 26, wherein the processing problems include one or more of the following: (i) a use of an incorrect reticle to form the sample, (ii) an incorrect resist thickness, (iii) resist streaking, or (iv) a chemical mechanical polishing problem.

28. (original) A method as recited in claim 20, further comprising acquiring the image of at least two of the periodic targets simultaneously.

29. (original) A method as recited in claim 19, wherein each first structure has a first center of symmetry and each second structure has a second center of symmetry and wherein the

first center of symmetry and the second center of symmetry for each target are offset with respect to each other by a selected one of the predefined offsets.

30. (original) A method as recited in claim 19, wherein the overlay error is determined without comparing the measured optical signals to calibration data.

31-37. (cancelled)

38. (original) A method as recited in claim 1, wherein the measured optical signals are each in the form of a line image.

39. (original) A method as recited in claim 38, wherein each first structure has a first center of symmetry and each second structure has a second center of symmetry and wherein the first center of symmetry and the second center of symmetry for each target are offset with respect to each other by a selected one of the predefined offsets.

40. (original) A method as recited in claim 38, wherein the overlay error is determined without comparing the measured optical signals to calibration data.

41-42. (cancelled)

43. (new) A method as recited in claim 1, wherein the number of terms in each set of periodic functions is three and the number of periodic targets is four.

44. (new) A method as recited in claim 43, wherein the predefined offsets can be represented as Xa, Xb, Xc, and Xd so as to meet the following condition:

$Xa-Xc=Xc-Xb=Xb-Xd=Xd-Xa+P=P/4$, wherein P is a pitch of each of the four periodic targets.

45. (new) A method as recited in claim 1, wherein the predefined offsets include a +/-F constant and a +/-f0 constant, wherein the F constant equals ¼ of a pitch of the periodic targets and f0 constant is outside a region of interest for the determined overlay error and does not cause the uncertainty of the determined overlay error to allow an out-of-specification overlay error to be determined as an in-specification overlay error.